WAVETEK

OPERATION HANDBOOK

MODEL
SAM 3000

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What is A SAM 3000?

The SAM 3000 measures RF signal level, hum, carrier-to-noise ratio, and AC and DC power supply voltages. The four line, backlit LCD displays tuned frequency information and measurement data, as well as a continuous indication of current battery status. A special tilt measurement function allows you to balance an amplifier without constantly retuning the meter. A bar graph and numerical measurement display provides quick, precise results.

A Fiber SAM 3000 is also available, which includes a built-in fiber optic power meter.

A SAM 3000 is a rugged, reliable signal level meter with the following features/ benefits:

- Quick, easy keyboard tuning for maximum efficiency.
- Backlit LCD readout of tuned frequency or channel and the measurement result for precision measurements.
- Hi/Mid/Lo channel and favorite channel tuning keys for quick tuning to commonly measured frequencies.
- Keyboard selectable channel plans in memory, and two user programmable channel plans make the SAM 3000 adaptable to your system.

The standard SAM 3000 is tunable from 47 to 550 MHz in 125 kHz steps, and measures signals ranging in level from -35 to +60 dBmV. Options for the SAM 3000 include:

Sub Band:	Tunes from 4.5 to 550 MHz.
Sub/UHF Band:	Tunes from 4.5 to 890 MHz
SAM 3000 Bag:	A padded bag to provide added protection to the instrument.
SAM Rack Mount Kit:	(K210) Rackmount Panel Kit.

Standard accessories include: Operating Handbook, Battery Charger, Trunk Hook. Of course, the SAM 3000 has rechargeable NiCad batteries. Please look at the section "Battery Charging Basics" for proper charging procedures.

Your SAM 3000 may also be configured for use outside the U.S. You may custom program two channel plans in addition to those held in memory. See CHANNEL PLANS.

You may also configure your SAM 3000 for 50/60 Hz, 100/120 Hz and < 400 Hz HUM Tests, measurements, dBmV or dBμV and other user defined parameters. See the STAT FUNCTIONS.

SPECIFICATIONS

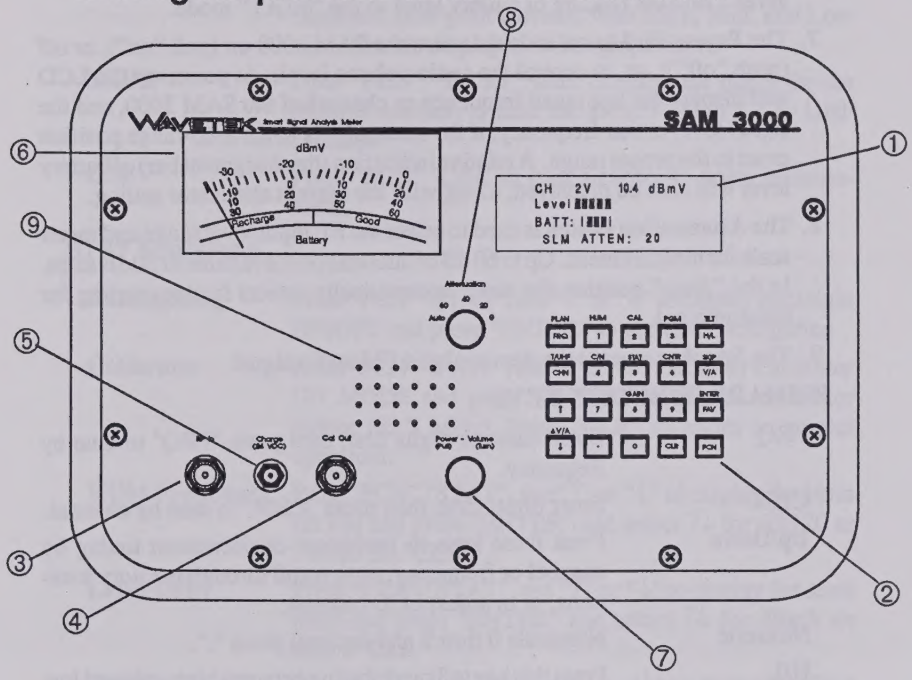
Frequency Range	
Standard:	47 to 550 MHz
Sub Option:	4.5 to 550 MHz
Sub/UHF Option	4.5 to 890 MHz
Frequency Accuracy:	± 20 kHz (4.5 to 550 MHz) at 25° C. ± 35 kHz all operating temperatures. ± 50 kHz (550 to 890 MHz)
Tuning Increment (Up or Down Arrow Key)	
In Frequency Mode:	125 kHz increments *
In Channel Mode:	Tunes to Next Video or Audio Carrier.
Resolution (I.F.) Bandwidth:	280 ± 50 kHz at 3 dB point.
Selectivity:	Sufficient to distinguish between two FM signals of equal amplitude 600 kHz apart. Sufficient to measure an audio carrier in the presence of a higher adjacent video carrier 40 dB greater in amplitude.
Subharmonics:	>45 dBc anywhere in the tuning bandwidth.
Return Loss:	>16 dB with 20 dB attenuation.
Level Measurement Range:	-35 to +60 dBmV +25 to +120 dBμV *Warning:* Do not connect any RF signal level greater than +70 dBmV to the RF input of ANY SAM
Level Accuracy:	± 1.0 dB (Typical)
Amplitude vs. Frequency (Flatness):	± 0.75 dB (ambient: 60° to 90° F)
Meter Tracking (Linearity)	± 0.75 dB (-35 to +60 dBmV)
Temperature Variation	± 0.5 dB (relative to calibration at 70° F for ambient temperature extremes of 4° to 122° F (-20 to +50° C) (Typical)

* Although tuning increment is 125 kHz, the SAM 3000 may be used to measure carriers that are offset from the exact tuned frequency, because the resolution bandwidth of the meter is 280 kHz. This means that a carrier as far away as one half tuning increment (62 kHz) will be well within the resolution bandwidth, and the measurement will be within 0.5 dB of specified accuracy.

Range	Low: 0 - 4 V AC/DC 1 mV Mid: 4 - 40 V AC/DC 10 mV High: 40 - 250 V AC/DC 100 mV
Dimensions	6.5 in (16.51 cm) High x 8.75 in (22.23 cm) Wide x 6.5 in (16.51 cm) Deep.
Weight	7 lb 5 oz (3.4 kg)
Case	Impact and water resistant Lexan®
Battery	
Type	Nickel Cadmium
Life	>8 hours, Normal (Intermittent) Operation 4.5 hours continuous (less with backlight and options).
Charge Time	~16 hours *(See "Battery Charging Basics")*

®*Lexan is a registered trademark of General Electric.*

Getting Acquainted With Your SAM 3000



SAM 3000 Front Panel

Instrument Controls

Please refer to the front panel drawing to locate the particular numbered item described below.

1. The **LCD (Liquid Crystal Display)** shows the tuned frequency or channel, digits entered via the keyboard, measurement result, and other control information.
2. The **keyboard**, for tuning by channel or frequency, and initiating test routines. (The digits are entered first then press the channel or frequency key.)
3. The **RF In connector** is for the input signal to be measured.
4. The **Cal Out connector** is for the calibrator output signal, to be connected to the RF In connector before calibrating.
5. The **charge connector**, to be connected to wall mount charger for battery charging. The **"CHARGE" indicator** illuminates when the SAM 3000 is connected to the charger and receiving a charge. The SAM 3000 may be powered by its wall mounted charger in the lab, or other inside environments. *Please see "Battery Charging Basics" before charging the battery.*

6. The **meter** indicates the signal level at the tuned frequency or channel, or gives a relative reading of battery level in the "STAT" mode.
7. The **Power-Pull knob** is used to turn the SAM 3000 on (pull "on"), or off (push "off"); or, to control the audio volume level. At power-up the LCD will display the last tuned frequency or channel of the SAM 3000, and the signal level at that frequency, if the attenuator is in the auto-range position or set to the proper range. A relative indication (three segment bar) of battery level will also be displayed, along with the current attenuator setting.
8. The **Attenuation switch** is used to select the RF input level range and meter scale for measurement. Up to 60 dB of attenuation is available in 20 dB steps. In the "Auto" position the meter automatically selects the best setting for measurement.
9. The **Speaker** sounds the demodulated FM audio signal.

PRIMARY FUNCTION KEYS

FRQ	Enter numeric digits first, then press "FRQ" to tune by frequency.
CHN	Enter digits first, then press "CHN" to tune by channel.
Up/Down	Press these keys to Increment or decrement tuning by channel or frequency, or to scroll through memory locations, or to adjust LCD contrast.
Numeric	Numerals 0 thru 9 and decimal point ".".
H/L	Press this key to Toggle tuning between high, mid and low pilot frequencies.
V/A	Press this key to toggle tuning between video and audio carrier in the channel tuning mode.
FAV	Press this key to recall stored favorite channels or frequencies.
FCN	Press this key to start a secondary function. Functions are labeled in white letters above the key.
CLR	Press this key to Clear the display when keys are pressed by mistake, or to clear out of test modes.

Secondary Functions

PLAN	Press "FCN" "PLAN" to select a channel plan.
HUM	Press "FCN" "HUM" while tuned to an unmodulated (CW) carrier, to measure hum.
CAL	With the Cal Out connected to the RF In, press "FCN" "CAL" to calibrate the SAM 3000.
PMG	Press "FCN" "PGM" to program favorite channels and/or High/Mid/Low pilot frequencies.

TILT	Press "FCN" "TILT" to measure tilt based on levels of High and Low pilot carriers, with High, Mid, and Low carrier levels displayed in bar graph form.
T/UHF	Press "FCN" "T/UHF" after entering the digits for the channel number, to tune the SAM 3000 to a T or UHF channel.
C/N	Press "FCN" "C/N" to start a carrier-to-noise measurement.

STAT Functions

Backlighting	Press "FCN" "STAT", use "↑" or "↓" to display Backlight ON/OFF and press "ENTER" to activate backlighting.
Calibrator	Press "FCN" "STAT", use "↑" or "↓" to display Calibrator ON MODE and press "ENTER" to turn on calibrator output (55.2 MHz). Press "CLR" to return to normal operation.
HUM Frequency	Press "FCN" "STAT", use "↑" or "↓" to display Set Hum filt Frq and press "ENTER" and select ↑↓ for 60/120 or 50/100 Hz "CLR"
Level Units	Press "FCN" "STAT", use "↑" or "↓" to display Set level units and press "ENTER" and select ↑↓ for dBmV or dBµV "CLR"
Test Point loss	Press "FCN" "STAT", use "↑" or "↓" to display Set Test pnt loss and press "ENTER" and enter 0-99 dB "ENTER" "CLR"
OPM Wavelength	(Optical Power Meter not available on the SAM 3000)
Battery Check	Press "FCN" "STAT", analog meter displays battery level.
Software Version	Press "FCN" "STAT" and the SAM 3000 software version will be displayed on the upper right corner of the LCD.

Other Secondary Functions

CNTR	Press "FCN" "CNTR", then press the "↑" or "↓" keys to adjust the LCD contrast.
SKIP	Used to delete channels when editing a custom channel plan.
GAIN	Press "FCN" "GAIN" to begin a relative gain or loss measurement.
ENTER	Used to accept keyed data when configuring the meter in different ways.

ΔV/A	Press "FCN" "ΔV/A" to read the difference in level between the video and audio carrier of the currently tuned channel.

Battery Charging Basics

A three segment "BATT" indicator is given on the LCD during most measurement modes. When three segments are displayed, the battery charge is high; when two segments are displayed the charge is medium; and when one segment is displayed the charge is low. The charge condition may also be tested by pressing "FCN" "STAT", and reading the analog meter. The battery should be recharged when the meter doesn't deflect to the "GOOD" region of the battery scale.

When you first receive your SAM 3000 the NiCad battery may have a nominal charge, and it should be charged before using it. A full charge lasts approximately 8 hours under typical usage (intermittent on/off). In continuous operation with the backlight and other options decrease the battery life). The SAM 3000 may be used while recharging, but the recharge time will be increased from 16 hours (overnight to 36 hours. Do not charge the SAM 3000 longer than 16 hours, as this can degrade battery performance and cause battery leakage. The SAM 3000 may be connected to the charger *with the instrument "on"* indefinitely without harm to the battery. (If the SAM 3000 has a UHF option, it will not charge while operating). Hum measurements are affected by the charger, and accuracy of these measurements may be degraded by up to 0.5%.

WARNING:

Use only the charger (Wavetek part number 1219-40-0267) supplied by Wavetek. Chargers used with the SAM Jr. are not compatible with the SAM 3000. Although another charger plug might fit into the SAM 3000 Charge connector, use of any other charger than the one provided for the SAM 3000 is not approved by Wavetek, and may result in serious damage to the SAM 3000. (This charger is the same as the SAM 1000/SAM 2000 charger.)

Replace the SAM 3000 battery pack only with the SAM 3000 battery pack supplied by Wavetek (part number 1219-40-0269). The SAM 3000 battery pack has a built-in current limiting device to provide protection against fire hazard, that is not typically found in battery packs available elsewhere.

Battery packs should be charged at a temperature of 65 to 75 degrees Fahrenheit. SAM 3000s have "trickle or float" battery charging circuit. The meter may remain connected to the specified Wavetek wall-charger continuously, with no degradation in battery performance, as long as the instrument is turned "on". Note: SAM 1000/2000, SAM 1500, LineSAM, & SAM 3000 wall-chargers *are not compatible* with the SAM Jr.

Battery packs should be stored at 65 to 75 degrees Fahrenheit. The charge acceptance of NiCad batteries decreases temporarily after long-term and/or high temperature storage conditions, but will return to normal after 1 -3 charge/ discharge cycles.

NiCad batteries can be charged and discharged several hundred times (approx. 500) under normal usage conditions. A battery pack has reached the end of its life when its capacity falls below 80%.

The capacity of NiCad battery packs decreases with decreasing temperature. The average pack will lose approximately 35 to 40% of its room temperature capacity at -5 degrees Fahrenheit.

Tell The SAM 3000 Your Channel Plan (Standard, HRC, etc.)

The SAM 3000 may be tuned by entering a specific channel number and pressing the channel key. The frequency that corresponds to the channel number depends on the channel plan the SAM 3000 is set up to use. A channel plan from the following list may be used:

NCTA Plan	JRD HRC Plan	GMBH-2
NCTA IRC Plan	Pal B/G	Custom Plan 1
NCTA HRC Plan	Pal A-UK	Custom Plan 2
JRD Plan	Belg-Ap	
JRD IRC Plan	GMBH-1	

To set the SAM 3000 up for one of these plans, press "FCN" then "PLAN". The current channel plan will be displayed. To change the channel plan simply press the "↑" or "↓" key until the code for the desired channel plan is displayed. Press the "CLR" key and the SAM 3000 will now tune according to the selected channel plan.

How To Program A Custom Channel Plan

To program a custom channel plan, first press "FCN" and "PLAN". The display will show the current channel plan. Press the "↑" or "↓" keys until the display shows "CUSTOM PLAN 1" or "CUSTOM PLAN 2". Next, enter the custom plan programming mode, by pressing "FCN" and "PGM". The display will show dashes to indicate frequency and "CH 0V" (meaning channel 0 video frequency). [If you would like to skip channel 0, press the "↑" key to increment the channel to the first channel number you would like in your plan]. Enter the video frequency for the indicated channel and press the "FRQ" key. Next, program the audio carrier frequency for this channel by pressing the "V/A" key, entering the audio carrier frequency, and pressing the "FRQ" key. Repeat this process until all of the desired channels are programmed. To exit the custom plan programming mode press "CLR".

Note:

It is not possible to select a custom plan that has not had at least one channel programmed. If there are no programmed channels when exiting the custom plan programming mode, a "CUSTOM EMPTY" error message will be displayed. Press "CLR" to return to the plan mode.

To delete a channel, enter the custom plan programming mode by pressing "FCN", "PLAN", pressing the "↑" or "↓" keys until the desired custom plan is shown, then pressing "FCN" and "PGM". Next press the "↑" or "↓" keys until the channel to be deleted is displayed. Press "FCN" "SKIP" and both the video and audio carriers for this channel will be deleted. Press the "↑" and "↓" "keys until the next channel to be deleted is shown and press "FCN" "SKIP". Repeat this process until all of the undesired channels are deleted. Exit the custom plan programming mode by pressing "CLR". Exit the channel plan selection mode by pressing "CLR" again.

How To Program Your Hi/Mid/Low And Favorite Channels

The SAM 3000 will tune to a preprogrammed Hi, Mid, or Low channel when the "H/L" key is pressed, and will show the levels of all three channels and the tilt when "FCN" "TILT" is pressed. The SAM 3000 will also tune to preprogrammed "favorite channels" when the "FAV" key is pressed.

To program Hi/Mid/Low and favorite channels, first press "FCN" "PGM". The display will show the currently configured "low" channel or frequency. You may change it by entering the digits and pressing "CHN" or "FRQ" as appropriate. Scroll through mid, hi, and the favorite channels using the up arrow key and program as desired. Press "CLR" when programming is complete to return to normal operation.

How To Select A Frequency For Measurement-Tuning Your SAM 3000

One of the most important, and beneficial features of the SAM 3000 is its quick tuning. You can tune by frequency, by channel, by favorite channel, or, with the press of a key to your high, mid and low pilot or test carriers.

Tuning By Frequency

To tune to any specific frequency, you simply enter the digits of that frequency and then press the "FRQ" key. For example, if you want to tune to 150 MHz, you enter 1, 5, and 0, then press the "FRQ" key. The display will show the digits as you enter them, and after the "FRQ" key is pressed it will show the tuned frequency: 150.000. If you want to tune around this frequency, for instance to find the frequency at which the meter is peaked, you simply press the "↑" or "↓"

key to increment or decrement the frequency in 125 kHz increments. Hold down the arrow key to continuously tune.

If you want to know what channel is near a given frequency, simply tune to that frequency and press the "CHN" key. The SAM 3000 will tune to the nearest video or audio carrier in the channel plan for which the SAM 3000 is configured, and the display will show the channel number.

If you are unable to tune the SAM 3000 to the exact frequency of the test carrier (for instance a carrier frequency of 150.062 MHz), tune to the nearest tunable frequency (in this instance 150.000 MHz). The test signal will be well within the 280 kHz resolution bandwidth of the meter and the accuracy of the measurement won't be off by more that 0.5 dB from the specified accuracy.

Tuning By Channel

To tune to any specific channel, you simply enter the digits of that channel and then press the "CHN" key. For example, if you want to tune to channel 14, you enter 1 and 4, then press the "CHN" key. The display will show the digits as you enter them, and after the "CHN" key is pressed it will show the tuned channel: CH 14. The SAM 3000 will be tuned to either the video or the audio carrier of channel 14, depending on the last channel carrier setting (a "V" or "A" will be displayed next to the channel number to indicate which carrier). To toggle the tuning from the video to the audio carrier, or vice versa, simply press the "V/A" key. The "V/A" key is effective only when the SAM 3000 is in the channel tuning mode (a channel is indicated on the LCD). Pressing the "↑" or "↓" key will tune the SAM 3000 to the next higher or lower channel respectively. Holding the arrow key down will continuously tune by channel.

If you want to know what frequency corresponds to a given channel number, simply tune to that channel and press the "FRQ" key. The video or audio carrier frequency will be displayed, depending on the last channel carrier setting (a "V" or "A" will be displayed next to the channel number to indicate which carrier).

Tuning In The Sub Or UHF Bands

To tune to a Sub or UHF band channel, enter the channel digits, then press "FCN" "T/UHF".

Hi/Mid/Lo Channel Tuning

To tune quickly to the preprogrammed high, mid, and low channels, simply press the "H/L" key. The SAM 3000 will tune from low to mid to hi channel with the (LOW, MID, HI) channel designation indicated in the lower left corner of the LCD.

Favorite Channel Tuning

To quickly tune to any of the favorite channels, simply enter the digit corresponding to that channel and press "FAV". To tune through the 8 preprogrammed favorite channels, after pressing "FAV" press the up arrow key. The currently tuned favorite channel designation will be shown in the lower left corner of the LCD. Press "CLR" to return to the normal channel/frequency tuning mode.

How To Measure A Test Signal

A test signal may be a signal at any frequency, for example a hum carrier at a non-standard channel frequency, or a signal generated by the MC-50 600 at any specific frequency, or a calibrator at 150 MHz (from a SAM I or III). The test signal should first be connected to the RF In connector on the SAM 3000. Tune the meter to the test carrier frequency by entering the frequency digits (for example: "1, 5, 0") and then press the "FRQ" key. The LCD display will indicate the digits as you enter them, then the tuned frequency (for example: "150.000") after the "FRQ" key is pressed. Set the attenuator switch to the setting that makes the meter read somewhere in the middle of the scale. If the attenuator is in the "Auto" position the meter will automatically find the best attenuator setting for measurement.

The attenuator setting is given on the bottom line of the LCD, and this setting determines which meter scale to use for measurement (see the table below). The meter is read by matching the attenuator setting (60, 40, 20, or 0) with the number indicated on the right-hand side of the scale. Each segment on the meter scale equals 1 dB.

	dBmV	dBµV
SWITCH SETTING	**METER RANGE**	**METER RANGE**
0 dB	-35 to 0 dBmV	+25 to 60 dBµV
20 dB	-15 to +20 dBmV	+45 to 80 dBµV
40 dB	+5 to +40 dBmV	+65 to 100 dBµV
60 dB	+25 to +60 dBmV	+85 to 120 dBµV

Test Point Loss Compensation

You may configure the SAM 3000 to automatically add the test point loss from all signal level measurements. This gives you the amplitude of signals on the system without the need to mentally add the test point loss. (This assumes that the specified test point loss is accurate). To set up the test point loss compensation feature, press "FCN" "STAT", use "↑" or "↓" to display Set Test Pnt Loss and press "ENTER".

When And How To Calibrate Your SAM 3000

The SAM 3000's RF circuitry is naturally subject to changes in temperature, and these changes tend to cause amplitude measurement variations. These variations

may be easily compensated by calibrating the SAM 3000 at or near the temperature at which it will be used. The convenient built-in calibrator makes calibration a simple process.

To calibrate the SAM 3000, simply connect the calibrator output (Cal Out) to the RF input (RF In) with a 3 to 4 foot jumper. Next, press "FCN", "CAL". The LCD will show "CALIBRATION", and the meter will deflect to 10 dB below full scale. When calibration is complete, the meter will return to normal operation, and the meter is calibrated.

The calibrator is a precision 55.2 MHz oscillator, which is switched "on" when the Cal function is implemented. The RF input is measured, and this measurement is compared to the known calibrator level. The SAM 3000 is then recalibrated to the known calibrator level.

The calibrator may be activated for use in other tests by pressing "FCN", "STAT" "ENTER". This function is provided to enable quick tests of component loss and isolation as described in the application section of this manual. To avoid possible measurement procedure errors, the meter remains tuned to 55.250 MHz while the calibrator is "on". This also ensures that the calibrator is not left "on" accidentally, which would shorten battery life.

An MC-50 400 should not be used to check the SAM 3000's peak detector. (Peak detector operation may be verified by turning modulation on and off to ensure that the meter reads both modulated and unmodulated signals consistently and accurately). The SAM 3000 peak detector is designed to measure horizontal sync suppression scrambled signals accurately, based on the 60 Hz vertical interval, and for this reason doesn't read accurately when the only modulation present is a simulated 15,750 Hz modulation.

How To Set-up Headend Levels

The SAM 3000 has two special features to improve headend alignment efficiency: The Reference Level Function, and the Delta V - A Function (video/audio carrier ratio). These features simplify the process of aligning the headend for a flat output. The first step is to measure and adjust the channel 2 video carrier to the desired amplitude. Next, press "FCN" "GAIN". This makes the channel 2 signal amplitude the reference for the other carriers, and all subsequent measurements while in this mode will be "normalized" to the channel 2 carrier amplitude. The display will show 0.0 dB, unless the signal amplitude changes. You may now step through the channels using the up arrow key, and adjust each modulator or processor until the level reads 0.0 dB. After this is done, all of the video carriers will be aligned to the same level as the channel 2 video carrier, and the audio carriers may be measured and adjusted as necessary. Press "CLR" to return to normal operation.

To set the audio carriers, tune to channel 2 and press "FCN" "ΔV/A". The difference between the channel 2 video carrier and the channel 2 audio carrier

will be displayed. (The FCC guidelines suggest a minimum of 13 dB and a maximum of 17 dB for this ratio). After adjusting channel 2 audio signal amplitude, press the up arrow key to tune to the next channel in sequence, and the display will show the video/audio carrier ratio for that channel. Continue this process until all of your channels are aligned. Press "CLR" to return to normal operation.

How To Measure System Tilt - Balancing An Amplifier

A cable system is designed for unity gain, and each type of amplifier (trunk, bridger/line extender) output should be as close to identical as is physically possible. The amplifiers are set up with specified levels for signals at the high and low end of the spectrum that are used for Automatic Gain Control (AGC) or Automatic Slope Control (ASC). In the amplifier balancing process, these signals are measured and adjusted to specification. Before making an adjustment, be sure that there is not a problem in the system that *should not be compensated with an adjustment but a repair is needed.* If the signal measured is more than a couple of dB from where it should be, some investigation should be done to determine the source of the discrepancy.

To balance the amplifier, with the AGC and ASC switched "off", first measure the high pilot level and adjust it to the specified level with the gain control. The gain control tends to effect the overall amplitude throughout the spectrum equally. Then measure the low pilot level, and adjust it to the specified level using the slope control. The slope control effects the low end of the spectrum more than the high end. Tune back to the high end and repeat this process - the controls interact with each other - until the pilots are "balanced". Then switch "on" the AGC and ASC wait a moment to measure the signal levels with AGC and ASC activated.

The SAM 3000 makes this process simple through the provision of a Hi/Lo (H/L) pilot tuning key. Pressing this key toggles the tuning through the configured high end, mid and low end channels. (See How To Program Your Hi/Lo Pilots And Favorite Channels). To further simplify the process the "TILT" feature provides and LCD bar graph readout of the low, mid and high pilot levels (press "FRQ" to toggle the numerics from channel or frequency to measured carrier levels) and the slope (difference between high and low pilot levels). To activate this function, press "FCN", then "TILT". This feature makes it possible to balance the amplifier without repeatedly tuning the meter.

How To Measure Hum

Hum is defined by the NCTA Recommended Practices as "amplitude modulation at power frequencies". The SAM 3000 measures percentage of hum on a CW carrier. The first step in measuring hum is to tune to the CW test carrier frequency. Next, press "FCN" "HUM". The tuned frequency, the percent hum,

and the hum component being measured are displayed on the top line of the LCD. You may scroll through 60 Hz, 120 Hz and <400 Hz by pressing the up or down arrow key. The ability to discern which component (60 or 120 Hz) is contributing the most to the hum modulation. A 60 Hz modulation component suggests a possible corroded connector, a 120 Hz component tends to indicate a possible failure related to the DC supply in the amplifier - possibly a capacitor going bad and aggravating the ripple.

How To Measure Carrier-To-Noise

The SAM 3000 has a special Carrier-to-Noise measurement feature. This measurement is simply a comparison in amplitude between the reference signal and the noise. The reference carrier amplitude must be at least +20 dBmV at the RF input of the SAM 3000 to provide an adequate measurement range for measuring system noise as opposed to instrument noise. The noise measurement automatically corrects to reflect a 4 MHz bandwidth, peak detection vs. average noise, and IF impulse bandwidth.

To make a C/N measurement, first choose a good frequency for the measurement. The noise measurement must be made at least 2 to 2.5 MHz from any other carrier on the system. The video carrier for channel 2 is commonly used for a reference carrier, and the noise is then measured 2 to 2.5 MHz below this carrier. For the purpose of this example, let's assume the measurement will be made at channel 2 and the video carrier frequency is 55.250 MHz. First, tune the meter to 55.250 MHz. Next, press "FCN" and then "C/N". The display will show the noise measurement correction factor. Tune down to 53 MHz. Tune up and down using the "↑" and "↓" arrow keys to find the highest C/N reading, and to assure that you are not measuring a beat (intermod) product.

How To Measure Leakage

Leakage signals may be measured using the SAM 3000, and a Wavetek RD-1 tunable dipole antenna. The RD-1 has a built-in 16 dB preamplifier to boost the received signal for measurement on the SAM 3000. A loop-through provision is made on the RD-1 to permit the use of a bandpass filter prior to the pre-amplification of the leakage signal to limit intermod effects that result from measuring a low level signal in the presence of other signals at much higher levels.

The SAM 3000 should be tuned to the leakage measurement frequency, usually a video carrier in the mid-band (108 - 140 MHz). The dipole antenna elements should be adjusted to the correct length to correspond to the measurement frequency (a chart is given on the back page of the RD-1 Manual). The FCC prescribes a measurement procedure for leakage that should be followed. This specifies that the leak should be measured at a distance of 10 feet, with the antenna 10 feet off the ground, and 10 feet from any reflecting surface. Rotate the antenna to obtain the peak measurement, and record the measurement in your leakage log.

To convert the level measurement from dBmV to uV/m use the following equations (be sure to subtract the 16 dB gain of the RD-1 preamplifier first):

First convert from dBmV to uV $\quad \mathbf{E_{uV} = inverse\ Log\ (dBmV/20) * 1000}$

Next find uV/m $\quad \mathbf{uV/m = 0.021 * E_{uV} * F}$

where: E_{uV} = Receiver input terminal voltage in uV
F = Tuned measurement frequency
uV/m = Measured field strength in uV/m

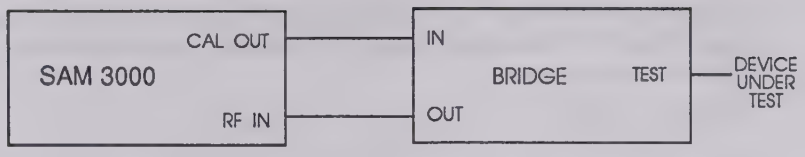
How To Measure Return Loss

Return loss (usually specified in dB) is the ratio of the original signal to the reflected signal at a junction point in a circuit. Typically, this is at a coaxial cable connection to the input or output of a piece of equipment. With a perfect connection (which, of course, does not exist because of impedance mis-matches due to inductive, resistive, and capacitive factors, two of which are frequency dependent), all the signal is transmitted and none is reflected (return loss = infinity dB). At the other extreme, if a transmission line (coaxial cable) is terminated either in either a short or an open, none of the signal is transmitted and all of it is reflected (return loss = 0 dB). The greater the return loss figure (specified in dB), the better the connection and transmission of the signal through the connection.

The return loss specification describes quality of the connection, and also the deviation of a device input or output from its nominal impedance (75 ohms for CATV applications) as well as the voltage standing wave ratio (VSWR). VSWR is the ratio of the maximum and minimum voltages on the transmission line created by the interference of the original and reflected signals.

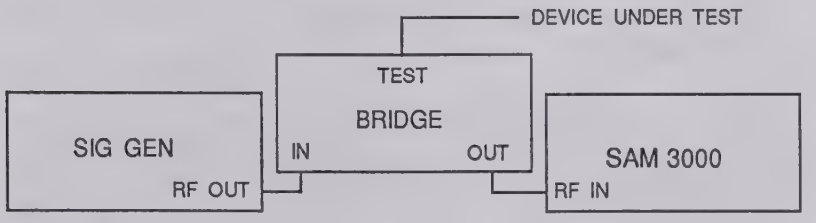
For example, if a 1 V signal were applied to a device whose input has a return loss specified at 20 dB, the reflected signal will be 20 dB lower than the original signal. Thus, 0.1 V will be reflected and 0.9 V will be transmitted. If the return loss of the device were 40 dB, 0.01 V would be reflected and 0.99 V would be transmitted.

Return loss may be measured using the SAM 3000 and a return loss bridge (Wavetek FB40-75). Using the SAM 3000's internal calibrator (55.2 MHz) enables a quick test, when a signal generator is unavailable. The first step is to connect the "Cal Out" to the bridge input, and the bridge output to the SAM 3000 RF In. Next, turn the calibrator on by pressing "FCN" "STAT" "ENTER". Next, activate the relative measurement mode by pressing "FCN" "GAIN". The LCD will display "0.0 dB". Now, connect the device to be tested to the bridge test port and the return loss will be displayed.



Return Loss Test Set-up Using SAM 3000 Calibrator

Return loss may also be measured with the SAM 3000 using a return loss bridge (Wavetek FB40-75) and a signal generator (Wavetek MC-50 600). Connect the equipment as shown. With the bridge test port "open", apply a signal at the desired frequency from the signal generator to the input of the bridge, and read the signal level at that frequency from the bridge output with the SAM 3000. Press "FCN" "GAIN". The top line of the LCD will display "0.0 dB". Next connect the device under test to the bridge test port, and the return loss will be indicated on the top line of the LCD.



Return Loss Test Set-up Using a Signal Generator

How To Test Taps And Splitters

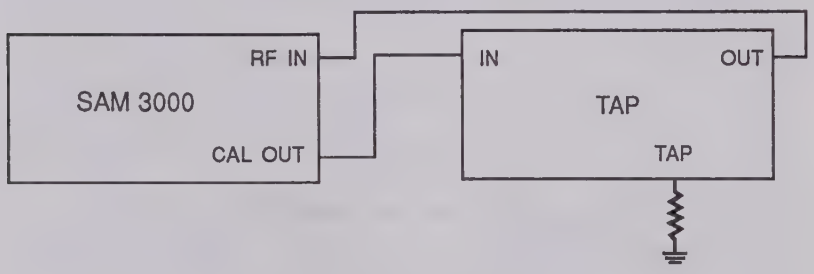
The preferred method of testing passive components such as splitters and taps utilizes a sweep generator, RF detector, and oscilloscope; however, and operational check (adequate for most circumstances) can be performed using a SAM 3000 and a signal generator (Wavetek MC-50 600). If a signal generator is not available, the TV channel carriers themselves (coupled through appropriate amplifiers and attenuation pads) can be used as test signals.

The method is to set up a reference (0.0 dB) level by connecting the reference signal to the SAM 3000 RF In, and pressing "FCN" "GAIN". Then the reference signal is routed through the device under test, and the top line of the LCD will display the loss of the device. The SAM 3000 calibrator may be used for any of these tests to perform a quick go/no-go test at the calibrator frequency when a signal generator or system test point is unavailable. The calibrator is activated

by pressing "FCN" "STAT" "ENTER". The relative measurements described below are then performed by pressing "FCN" "GAIN", and then inserting the device to be tested.

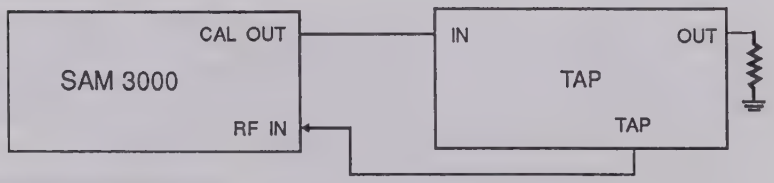
Testing Taps

There are three significant parameters to test on a tap (broadband directional coupler): through loss (input to through output); tap loss (input to tapped output); and isolation (tapped output to through output). To test through loss, first tune to the reference signal frequency and press "FCN" "GAIN". The top line of the LCD will display "0.0 dB". Next, connect the signal to the tap input, terminate the tapped output, and connect the through output to the SAM 3000 RF In. The through loss will be displayed on the top line of the LCD (typically <1 dB).



Through Loss Test Set-up (Tap)

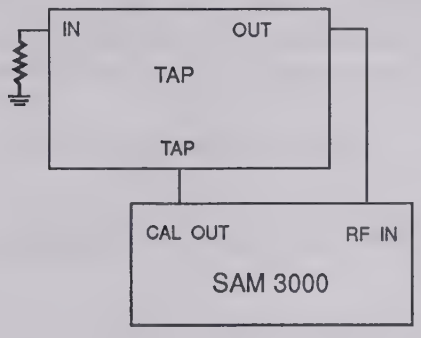
To test tap loss, (after setting up the 0.0 dB reference with a jumper cable) connect the calibrated reference signal to the tap input, and with the through output terminated, connect the SAM 3000 to the tapped output as shown. The tap loss will be displayed on the top line of the LCD. (The tap loss should be the nominal value of the tap; i.e., a 20 dB tap should have a tap loss of 20 dB).



Tap Loss Test Set-up

To test tap isolation, (after setting up the 0.0 dB reference with a jumper cable) connect the calibrated reference signal to the tapped output, and with the input terminated, connect the SAM 3000 to the through output as shown. The top line

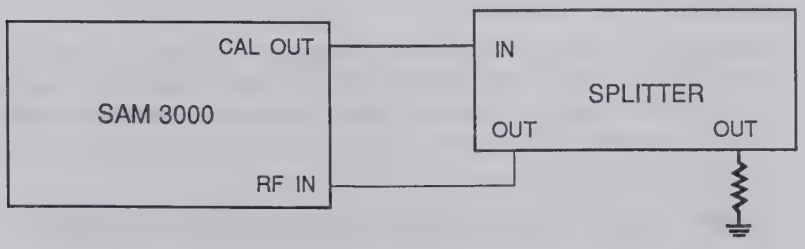
of the LCD will display the isolation. Ideally, no signal should reach through the output; however, in practice, the isolation is typically 20 dB plus the tap loss.



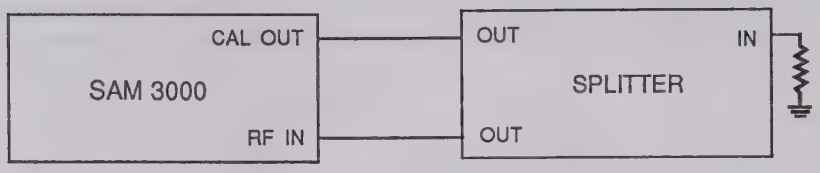
Isolation Test Set-up (Tap)

Testing Splitters

The procedures for testing splitters (broadband power dividers) are virtually identical to those for testing taps. The parameters to be measured are through loss (for each "leg" of the splitter) and isolation. The figures below show the test connections for a two-way splitter. Four-way and eight-way splitters are simply multiple two-way splitters in series. A "low-high" splitter will have different attenuation pads in each splitter "leg". The typical through loss for each leg of a two-way splitter is 3.5 dB. For four-way and eight-way splitters, the typical through losses are 7 dB and 11 dB, respectively. Typical isolation between "legs" of a two-way splitter is 20 dB. For four-way and eight-way splitters, the isolation will vary depending on the splitter's internal configuration, but should always be > 20 dB.



Through Loss Test Set-up (Splitter)



Isolation Test Set-up (Splitter)

A Simple Test To Verify The Operation Of Your SAM 3000

To make sure the SAM 3000 has an adequate supply of power, and to eliminate the battery as a source of failure, connect the SAM 3000 to the wall-mounted charger supplied with the meter. The "CHARGE" LED should be illuminated. (Please refer to "Getting Acquainted With Your SAM 3000" section of this manual if you're unsure of the location of the items described). Turn "on" the SAM 3000. The LCD will show the frequency or channel to which the meter was last tuned, and the meter needle will show no level (no meter deflection).

Connect a test signal (calibration source) to the RF input. If the test signal is from a signal generator, tune the generator to the frequency of the SAM 3000, and set the output to -5 dBmV. The meter on the SAM 3000 should read the level of the signal. Be sure the attenuator is in the "Auto" position or set to obtain an on-scale reading. At -5 dBmV, with a 0 dB attenuator setting, the meter needle should be 5 segments below the "0" on the scale. The LCD will show the tuned frequency and -5 dBmV.

Connect a cable drop to the SAM 3000 RF In connector. Tune to channel 2, by pressing "2" then "CHN". The LCD will show "CH 2". Press the "V/A" key, and turn the volume control clockwise until the audio is set at a comfortable listening level. The audio should be clear and intelligible. Turn the volume off (counter-clockwise to the stop).

Press "FCN" "STAT". The meter will deflect to the "GOOD" region of the battery test scale. If the battery needs to be charged, the meter needle won't deflect beyond the "recharge" section of the battery scale when the charger is disconnected. Please refer to the "Battery Charging Basics" section of this manual for proper charging procedures.

What To Do If Your SAM 3000 Needs Service

If you are not sure if your SAM 3000 is working properly, please go through the "How To Check Your SAM 3000's Performance" section of this manual. If you have any question about how to use your SAM 3000, or are unsure of its operation, please call for **Applications Assistance: 1-800-622-5515.**

If your SAM 3000 needs service, please call **Customer Service: 1-800-851-1198.** Have your SAM 3000 serial number ready. Wavetek's friendly Customer Service Representative will ask for the serial number, your address for return shipping, and a description of the problem. They will also want your name, in case the Service Technician needs to call you to discuss the problem in further detail to make a proper diagnosis.

REFERENCE GUIDE

TURN ON/OFF

Pull-out/push-in POWER - VOLUME knob.

ACTIVATE BACKLIGHTING

Step 1: To turn meter and LCD backlighting "on" or "off" press [FCN] [STAT].

Step 2: Press [↑] or [↓] until "Backlight" is displayed and press [ENTER].

CHOOSING A CHANNEL PLAN

Channel Plans:

NCTA:	Standard, HRC, IRC	PAL: B/G, A
Jerrold:	Standard HRC, IRC	GMBH: 1, 2
Custom:	2 User programmable plans	BELG: AP

Step 1: Press [FCN] [PLAN].

Step 2: Press [↑] or [↓] to scroll through channel plans.

Step 3: Stop scrolling when desired plan is displayed and press [CLR].
LineSAM will tune according to that plan.

PROGRAMMING A CUSTOM CHANNEL PLAN

Step 1: Press [FCN] [PLAN].

Step 2: Press [↑] or [↓] until display shows the custom plan to be programmed.

Step 3: Press [FCN] [PGM].

Step 4: Press [↑] until the channel number to be programmed is displayed.

Step 5: Enter the video frequency, then press [FRQ].

Step 6: Press [V/A] enter the audio carrier frequency and press [FRQ].
Repeat steps 4 through 6 until the desired channel plan is entered.

Step 7: Exit the Custom Plan Programming Mode by press ing [CLR].
Exit the Channel Plan Selection Mode by pressing [CLR] again.

DELETING A CUSTOM CHANNEL

Step 1: Press FCN PLAN .

Step 2: Press ↑ or ↓ until display shows the Custom Plan to be modified.

Step 3: Press FCN PGM .

Step 4: Press ↑ until channel number to be deleted is displayed.

Step 5: Press FCN SKIP and both the video and audio carriers for this channel will be deleted.
Repeat steps 4 and 5 until all of the undesired channels are deleted.

Step 6: Exit the custom plan programming mode by pressing CLR .
Exit the Channel Plan Selection Mode by pressing CLR again.

FREQUENCY TUNING

Enter digits, then press FRQ.
Incremental Changes: Press ↑ or ↓ to tune up or down in 125 kHz steps.

CHANNEL TUNING

Enter digits, then press CHN .
Incremental Changes: Press ↑ or ↓ to tune up or down one channel.

SUB/UHF TUNING

Enter digits, then press FCN T/UHF .
Incremental Changes: Press ↑ or ↓ to tune up or down one channel.

FREQUENCY TO CHANNEL/CHANNEL TO FREQUENCY TUNING

Press CHN or FRQ to change from on tuning mode to the other.
In Sub of UHF modes press FRQ to change from channel to frequency mode.
Press FCN CHN to change from frequency to channel mode.

VIDEO/AUDIO TUNING (CHANNEL TUNING MODE ONLY)

Press [V/A] to change from video to audio, or audio to video carrier frequency.

PROGRAMMING FAVORITE CHANNELS - HI/MID/LO PILOT SET-UP

Step 1: Press [FCN].

Step 2: Press [↑] or [↓] to scroll through LO, MID, HI and 8 Favorite Channel/Frequencies.

Step 3: At each position, enter digits, then press [CHN] or [FRQ] to program the channel or frequency.

Step 4: Press [CLR] to save the programmed channels and return to normal operation.

FAVORITE CHANNEL/FREQUENCY RECALL

Step 1: Enter digit for Favorite Channel number, then press [FAV].

Incremental Changes: Press [↑] or [↓] to scroll tuning Favorite Channels.

Step 2: Press [CLR] to return to normal operating mode.

VIDEO TO AUDIO CARRIER LEVEL RATIO

Step 1: Tune to desired channel (see Channel Tuning) (Video Carrier.)

Step 2: Press [FCN] [V/A].

Incremental Changes: Press [↑] or [↓] to tune up or down through channel plan, while remaining in the V/A mode.

Step 3: Press [CLR] to return to normal operation.

TILT FUNCTION

(LO, MID, HI pilots must have been programmed before this function
can be implemented.)

Step 1: Press [FCN] [TILT].

Step 2: Press [CLR] to return to normal operation.

CALIBRATION

Step 1: Connect RF IN to CAL OUT.
Step 2: Press FCN CAL .
Step 3: Disconnect RF IN from CAL OUT.

CALIBRATOR ON/OFF (+10 dBmV OUTPUT)

Step 1: Press FCN STAT .
Step 2: Press ↑ or ↓ until "CALIBRATOR ON" is displayed.
Step 3: Press ENTER .
Step 4: Press CLR to return to normal operation (CALIBRATOR OFF).

RELATIVE LEVEL MEASUREMENTS

Step 1: Tune to reference carrier frequency.
Step 2: Press FCN GAIN. The reference carrier level becomes "0 dB".
Step 3: Connect device under in test in series with reference carrier and RF IN.
Step 4: Gain or loss of device under test is displayed.
(The LineSAM calibrator may be used as a reference carrier for this test).
Press CLR to return to normal operation.

HUM MODULATION MEASUREMENT

After tuning to a CW (unmodulated) carrier:

Step 1: Press FCN HUM .
Step 2: Press ↑ or ↓ to select 50 or 100, 120 or 400 Hz Hum measurement.
(50/100, 60/120 set in "stat" function).
Step 3: Press CLR to return to normal operation.

CARRIER TO NOISE RATIO MEASUREMENT

Step 1: Tune to desired reference carrier.
Step 2: Press FCN C/N .
Step 3: Press ↑ or ↓ to tune to noise measurement frequency (null).

The C/N ratio is displayed, along with the measured level of the reference carrier.

Step 4: Press [CLR] to return to normal operation.

DISPLAY CONTRAST ADJUSTMENT

Step 1: Press [FCN] [CNTR].

Step 2: Press [↑] or [↓] to adjust contrast as desired.

Step 3: Press [CLR] to return to normal operation.

BATTERY CHECK

A relative indication of battery level is given with a bar graph in normal operation.

Step 1: Press [FCN] [STAT] to read the battery level on the analog meter.

Step 2: Press [CLR] to return to normal operation.

ERROR MESSAGES

If a problem exists in your SAM 3000, one of the following messages may appear on the display. If this occurs please call - Wavetek Customer Service at 1-800-851-1198.

ERR 1: EDIT ERROR	incorrect keystroke sequence when editing frequency or channel
ERR 2: CALIBRA RANGE	the unit cannot be calibrated at the current temperature since the IF gain range is insufficient to calibrate
ERR 4: FREQ ERROR	the test plan definition requested cannot be honored because the test plan is already in use; you must delete all sets which use the plan before you can redefine the plan
ERR 5: CHN NOT PGM	channel chosen is not programmed in the current custom channel plan
ERR 6: FREQ RANGE	frequency chosen is too high or too low for unit
ERR 8: NOT CUSTOM PL	PMG function was requested on a non-custom channel plan
ERR 9: HUM ERROR	Hum cannot be measured at the current temperature since the IF gain range is insufficient to measure Hum
ERR 10:NO SUB OPT	sub channel request cannot be honored because required sub option is not installed
ERR 11:NO UHF OPT	UHF channel request cannot be honored because required UHF option is not installed
ERR 12:RECHARGE BAT	the unit's internal batteries are discharged, recharge must be done before unit can be used
ERR 13:CALB MEMORY	an error was detected in the unit's calibration memory indicating internal ROM failure

ERR 14:PGM MEMORY	an error was detected in the unit's program storage memory (FAV channels, HI/LO/ MID); check/re-program these
ERR 15:CUSTOM EMPTY	an attempt was made to choose a custom channel plan which has not been programmed
ERR 16:KEY INACTIVE	the key or function requested is not active in the current unit state
ERR 24:CUSTOM MEMRY	an error was detected in the unit's custom channel plan storage memory; check/re-program these
ERR 25:NO VIDEO CAR	no video carrier found
ERR 26:NO AUDIO CAR	no audio carrier found
ERR 27:AUD TOO LOW	audio carrier is outside the measurement range in this mode
ERR 28:VID TOO LOW	video carrier is outside the measurement range in this mode

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